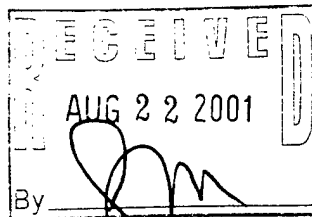


# REPORT DOCUMENTATION PAGE

Form Approved  
OMB NO. 0704-0188

Public Reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comment regarding this burden estimates or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188,) Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE	3. REPORT TYPE AND DATES COVERED FINAL 01 May 96 - 30 Apr 99	
4. TITLE AND SUBTITLE Core Support of the Board on Mathematical Sciences		5. FUNDING NUMBERS DAAH04-96-1-0092		
6. AUTHOR(S) John Tucker				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Academy of Sciences		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U. S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211		10. SPONSORING / MONITORING AGENCY REPORT NUMBER 34899.1-MA		
11. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.				
12 a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.		12 b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words)  This proposal summarizes activities of the Board on Mathematical Sciences (BMS) during the period August 1, 1998 to Jul 31, 1999 and describes future plans of the Board. The BMS activities supported exclusively by core funding are the annual Department Chairs Colloquia, symposia, specific reports, the initiation of all projects, continuous oversight of all activities, and partial support of the Committee on Applied and Theoretical Statistics (CATS). Other activities of the Board include reporting on research opportunities, education in the mathematical sciences, interaction of mathematical sciences with other areas, health of the mathematical sciences, and emerging research directions.				
14. SUBJECT TERMS		20010831 014		15. NUMBER OF PAGES 5
				16. PRICE CODE
17. SECURITY CLASSIFICATION OR REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION ON THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	



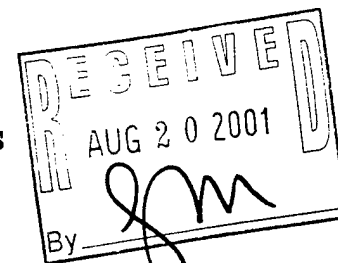
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THE NATIONAL ACADEMIES  
COMMISSION ON PHYSICAL SCIENCES, MATHEMATICS, AND APPLICATIONS  
BOARD ON MATHEMATICAL SCIENCES

Final Report to the Army Research Office

CORE SUPPORT OF THE BOARD ON MATHEMATICAL SCIENCES



## SUMMARY

This proposal summarizes activities of the Board on Mathematical Sciences (BMS) during the period August 1, 1998 to July 31, 1999 and describes future plans of the Board. The BMS activities supported exclusively by core funding are the annual Department Chairs Colloquia, symposia, specific reports, the initiation of all projects, continuous oversight of all activities, and partial core support of the Committee on Applied and Theoretical Statistics (CATS). Other activities of the Board include reporting on research opportunities, education in the mathematical sciences, interaction of mathematical sciences with other areas, health of the mathematical sciences, and emerging research directions.

## 1. INTRODUCTION

In 1984 the National Research Council (NRC) established the Board on Mathematical Sciences to maintain awareness and active concern for the health of the mathematical sciences and serve as the focal point in the NRC for issues connected with the mathematical sciences. Dr. Robert MacPherson of the Institute for Advanced Study is the chair of the Board. The Board consists of 16 members representing the areas of core mathematics, applied mathematics, statistics, operations research, and scientific computing. The Board represents a broad cross-section of the profession, with members coming from a variety of academic institutions, industry, and national laboratories. The Committee on Applied and Theoretical Statistics (CATS) is a standing committee of the Board, and is currently chaired by Prof. Peter Bickel of the University of California at Berkeley; he serves also as an ex officio member of the Board. The Board's activities frequently involve seeking expert input from scores of mathematical scientists, other scientists, engineers, and medical personnel, including many members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The BMS reports to the Commission on Physical Sciences, Mathematics, and Applications (CPSMA) of the NRC.

For the period May 1, 1996 to April 30, 1999, BMS received \$62,000 from the ARO for its core activities. During this period, additional core support for BMS was received from the National Security Agency (NSA), National Science Foundation, Office of Naval Research (ONR), Department of Energy (DOE), and Air Force Office of Scientific Research (AFOSR). Board activities are described below.

## 2. BOARD ACTIVITIES

The Board on Mathematical Sciences holds regular meetings of the full Board and its Executive Committee to discuss projects, mission, strategy, and operations. Representatives of federal policy institutions, funding agencies, academia, industry, the professional societies, and the professional communities are often invited to attend. As needed, they are invited to speak on how the areas they represent have an impact on and are affected by the mathematical sciences as well as on their concerns, needs, or problems involving mathematical sciences. During the reporting period, the full Board met on November 12-13, 1998 and May 6-7. Both meetings were held in Washington, D.C.

The activities supported exclusively by core funding are the annual Department Chairs Colloquia, symposia, specific reports, the initiation and oversight of all projects, and partial core support of CATS. Other activities of the Board include projects on the health of the mathematical sciences, interactions between mathematical sciences and other areas, education, and emerging research directions. The activities of the Board fall into eight categories as described below.

As part of its oversight responsibility, the Board initiates all new projects, approves the membership of all specially convened committees and any standing committees, monitors the work of the committees, and reviews the production of final reports. Appendix B includes a listing of the reports produced by the Board and its special committees.

#### A. Department Chairs Colloquia

Each fall in Washington, the Board organizes and sponsors the Mathematical Sciences Department Chairs Colloquium for four-year colleges and universities. The speakers and panel members at the Colloquium included chairs of mathematical sciences departments, university administrators who come from the mathematical sciences community, representatives from business, industry, and government who make use of or are concerned with the mathematical sciences, and representatives of federal research and education programs. The colloquium provided current and future department chairs with information on the changing role of the mathematical sciences both within and outside academia. Attendees' evaluation comments were highly favorable. People attending are responsible for their own expenses and direct meeting costs are recovered through a registration fee, while staff and program development costs are borne by Board core funds.

The 1999 Department Chairs Colloquium will be held on November 12-13, 1999. A major figure in national science policy has been invited to be the keynote speaker. For this colloquium, a major session is being planned on the diverse forms of distance education and the issues that distance education presents for academic departments in the mathematical sciences. The meeting will also include talks and discussion sessions on such topics as departmental innovation/creativity, chair leadership, and innovative curriculum. A special attempt is being made this year to appeal to chairs from smaller schools, both in designing the colloquium program and in the registration drive. The Board's planning of the 1999 colloquium is being done with the help of Dr. Teresa Edwards, chair of the mathematics department at Spelman College, who is spending the period September, 1998 through August, 1999 with the Board as a NASA Administrator's Fellow. Dr. Edwards' presence has enabled the Board to leverage its core funding while also benefiting from her valuable insights about the mathematics profession.

#### B. Symposia on Science and Technology

The BMS periodically organizes, oversees, and sponsors focused symposia to inform decision makers and the scientific, engineering, and technology communities of important issues in the mathematical sciences and of the relation of the mathematical sciences to other areas and to national interests. Following are the topics and dates of symposia that the Board has organized or overseen:

- \* *Record Linkage Workshop*, March 20-21, 1997.
- \* *Actions for the Mathematical Sciences*, May 17-19, 1996.
- \* *Statistical Challenges and Possible Approaches in the Analysis of Massive Data Sets*, July 7-8, 1995.
- \* *Earth Shaking Analyses: Mathematical Sciences in Seismology*, June 1, 1995.
- \* *Large-Scale Structures in Acoustics and Electromagnetics*, September 26-27, 1994.
- \* *Motion, Control, and Geometry*, April 12, 1994.
- \* *Transportation and the Mathematical Sciences: The Changing Interaction*, May 13, 1993.
- \* *Clinical Trials and Statistics*, December 1, 1992.
- \* *Mathematics in Support of Industry*, October 25, 1991.
- \* *Mathematical Sciences, Technology, and Economic Competitiveness*, May 7, 1991.
- \* *The Future of Statistical Software*, February 22, 1991.
- \* *Partial Differential Equations*, May 9, 1990.
- \* *Statistics: A Guide to Assessing Societal Risk*, November 29, 1989.
- \* *Number Theory*, May 4, 1989.
- \* *Nonlinear Mathematics, Chaos, and Fractals*, April 28, 1988.
- \* *Statistics in Science, Industry, and Public Policy*, April 9, 1987.
- \* *Mathematics, the Unifying Thread in Science*, May 12, 1986.

A proceedings of the record linkages workshop, titled simply *Record Linkage Techniques—1997*, was released by the National Research Council during the reporting period.

### C. Health of the Mathematical Sciences

During the reporting period the Board finished a study for the National Science Foundation on the future roles, number, and support for U.S. mathematical sciences institutes. The study examined the role of the institutes in furthering mathematical research, gave a strong endorsement of the value of existing broad-based mathematical science research institutes in the United States, and recommended that NSF establish two new types of mathematical science research institutes. Copies of the final report, *U.S. Research Institutes in the Mathematical Sciences*, were mailed to you in May, 1999.

During the reporting period, the Board has been devoting significant energies toward planning a "decadal study" of the mathematical sciences. Such a study had been suggested by the NSF's Associate Director for Mathematics and Physical Sciences, in part because the physics and astronomy communities are in the midst of such exercises and the chemistry community is planning one. The Board's chair and others discussed the idea of such a study with a large number of mathematical scientists and found a broad consensus was that such a study was overdue. This decadal survey of the mathematical sciences will examine both research and education as well as interfaces with other disciplines such as physics, chemistry, computer science, materials science, and the biological sciences, and it will also assemble a number of short, expository articles that trace where mathematical sciences research significantly contributed to important societal goals. Among other things, the study will assess trends across this broad field, identify challenges that are expected in the next decade, examine modes of research funding, and identify instances where the mathematical sciences has benefited society. A project description has been approved by the National Research Council and funding proposals are in preparation.

### D. Articulating Emerging Research Directions

As result of a request from an NSA program director, with additional funding from the NSF, the Board's Committee on Applied and Theoretical Statistics (CATS) is planning a workshop to explore the state-of-the-art of computer modeling. This activity is timely because there is an increased reliance on computer simulation for the modeling, design, and evaluation of present and emerging complex systems such as semiconductors, automobiles, aircraft, spacecraft, transportation, government intelligence, and battlefield scenarios. The planned workshop will be held in conjunction with statistical researchers at the Los Alamos National Laboratory, and will likely be scheduled for fall, 1999.

In a related effort, CATS and the NRC's Ocean Studies Board are planning a joint workshop to explore the state of the statistics/ocean science interface: i.e., whether communication and collaboration are adequate, whether ocean scientists are using the best statistical tools, and whether the ocean sciences present important untapped research opportunities for the statistics community. This workshop, which might lead to a more complete study, is being planned for September 13-14, 1999 in Washington, D.C. It is funded by NRC internal money, which provides another means of leveraging the Board's core support. It is possible that these two CATS workshops will lead to a more ambitious project dealing with the mathematical foundations of computational science, or of the mathematics of uncertainty.

### E. Mathematical Sciences Interacting with Other Areas

The Board is also a key resource concerning the mathematical sciences within the National Research Council (NRC). For example, the Board cooperated with the Academy-Industry Program to produce a workshop in May 1999 on the topic of "How Much Can We Rely on Mathematical Modeling?" This workshop brought together an extraordinary range of leaders in computational science and mathematical modeling and focused on the value of mathematical modeling to industry.

As mentioned above, the Board/CATS will soon hold a joint workshop with the NRC's Ocean Studies Board, and is also planning a joint workshop with the NRC's Computer Science and Telecommunications Board. The latter workshop will explore the interface between the mathematical sciences and computer science, especially to expose collaborative opportunities beyond the traditional bounds of theoretical computer science and scientific computing. It is likely that the

Board will follow that workshop with a deeper investigation of the research opportunities for the mathematical sciences in computer science and engineering. Such an NRC study would aim to draw the fields closer together after several decades of drifting apart.

The Board has had a small involvement with the NRC's project titled "Strengthening the Linkages Between the Sciences and Mathematical Sciences" which is being conducted by the Commission on Physical Sciences, Mathematics, and Applications. That study was developed in response to requests from the presidents of the American Mathematical Society, the Society for Industrial and Applied Mathematics, the American Statistical Association, and the Institute of Mathematical Statistics.

#### F. International Connections

The National Academy of Sciences has transferred the management operations of all of its international committees to the NRC's Office of International Affairs (OIA). The day-to-day work of the U.S. National Committee for Mathematics and the U.S. National Commission for Mathematics Education is handled by OIA staff. The BMS serves in an advisory and oversight capacity to the USNCs, and also reviews and makes recommendations on membership, new projects, and international congress delegations for these committees.

### **3. RELATIONS WITHIN THE NRC AND WITH OTHER ORGANIZATIONS**

BMS works cooperatively with the other units of the NRC, especially the other Boards of the Commission on Physical Sciences, Mathematics, and Applications, the Committee on National Statistics (CNSTAT), and the Mathematical Sciences Education Board (MSEB). When appropriate, BMS works with the National Academy of Engineering (NAE) and the Institute of Medicine (IOM), the Academy Industry Program, and other NRC/NAS/NAE/IOM organizations. The Board has made its reports and information widely available by way of its redesigned World Wide Web home page (at the address [www2.nas.edu/bms](http://www2.nas.edu/bms)), and is presently working with other NRC units toward improving the Board's presence on the Web both in terms of functionality and ease of updating information.

NAS, IOM, NRC: BMS routinely gets NAS and NAE input on BMS activities and projects, and informs NAS mathematical sciences section members of noteworthy BMS developments or publications. Joint projects with other NRC and IOM boards are a significant part of the activity of BMS.

Government Agencies: Improving the level of appreciation for the mathematical sciences in all government agencies with science and technology concerns is a continuing objective of the Board. Agency representatives are invited to appropriate BMS meetings and functions. The BMS recently supplied information on mathematical sciences research developments in biomedical areas in response to a request from the Office of Science and Technology Policy.

The Congress: The Board will function, on request, as a source of information to Congress on research and education issues affecting or affected by the mathematical sciences, and provide relevant information as warranted to the mathematical sciences community from Congress.

Mathematical Sciences Professional Societies: The Board maintains close ties to the professional societies and does strategic planning in concert with them. Representatives of the professional societies are invited to appropriate BMS meetings and functions, and BMS representatives attend professional society meetings and functions upon invitation. For instance, the planning for the 1999 Chairs Colloquium included a lengthy discussion with MAA staff. The proposed committee for the decadal study of the mathematical sciences will include the current MAA president, three past presidents of the AMS, and a past president of SIAM, and another past president of SIAM is a current member of the Board.

Academic Departments of Mathematical Sciences: The BMS works through the Department Chairs Colloquia, direct dissemination of reports, and the professional societies to identify, assess, and address problems in mathematical sciences research, education, manpower, and management that academic departments are experiencing.

Industry: The BMS works through symposia and direct dissemination of reports to industry to identify and draw attention to areas in which increased use of the mathematical sciences will enhance competitiveness. The BMS recommends ways to prepare students for non-academic careers, and brings industrial perspectives to the attention of academic departments both through its reports that include this dimension, and Chairs Colloquia sessions on this sector of the mathematical community.

Foundations: The BMS works with foundations to identify topics of mutual interest, including mathematical sciences education, and provides assessment and recommendations.

Individual Mathematical Scientists: Through its publications, colloquia, and symposia, the BMS addresses the needs of the some 3,000 mathematical scientists active in research and the larger number engaged in education. The Board promotes mainstreaming of underrepresented groups (women, racial minorities, the disabled) both nationally and internationally.

The Public: The Board produces books and booklets of a popular nature to encourage public understanding of the benefits of the mathematical sciences in everyday life. The Board writes articles or assists reporters in writing articles for newspapers and magazines that present mathematics as useful, interesting, and worth studying. One component of the planned decadal study of the mathematical sciences will be standalone case histories, written with the aid of a professional science writer, recounting how mathematical or statistical research has had a tangible impact on issues that cut across U.S. society.

#### 4. CONCLUSION

The Board on Mathematical Sciences is a catalyst, convener, coordinator, and consensus builder for the mathematical sciences on the national level. It follows a policy of inclusion. It undertakes to do those activities that are necessary for nationwide reform, re-inventing, and revitalization but are unlikely to be carried out effectively by other organizations.

Appendix A is the roster of the Board. The Board staff currently consists of the director, a financial and administrative manager, and an administrative assistant, and is working to add a program officer to the staff.

#### PUBLIC INFORMATION ABOUT THE PROJECT

The NRC will post on its web site (<http://www.nas.edu>) a brief description of the project, as well as committee appointments with short biographies of the members, meeting notices, and other pertinent information, to afford the public greater knowledge of our activities, and an opportunity to make comments. The web site will also include an ongoing record of compliance to the requirements of Section 15 of the Federal Advisory Committee Act of 1997, and a certification of compliance when the study is completed.

#### FEDERAL ADVISORY COMMITTEE ACT

The Academy has developed interim policies and procedures to implement the Federal Advisory Committee Act, 5 U.S.C. § 1 et seq. (FACA), as amended by the Federal Advisory Committee Act Amendments of 1997, H.R. 2977, signed into law on December 17, 1997 (FACA Amendments). The FACA Amendments exempted the Academy from most of the requirements of FACA, but added a new Section 15 that includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a federal agency. In accordance with Section 15 of FACA, the Academy shall deliver along with its final report to the National Science Foundation a certification by the responsible staff officer that the policies and procedures of the National Academy of Sciences that implement Section 15 of FACA have been complied with in connection with the performance of the grant.